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Collaboration improves solar storm forecasting

Solar Fusion project builds bridges between two Air Force organizations, as well as provides accurate, timely, and relevant space environment data to the warfighter

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A recently established partnership between the Air Force Research Laboratory and the Air Force Weather Agency seeks to reduce the impact of space environmental effects on Department of Defense operational assets through enhanced forecasting of violent solar storms.

Modern military operations have expanded from the traditional domains of land, sea, and air to the ultimate high ground of the cosmos. Space-based communications, navigation, and surveillance systems can all be adversely affected by the environment in which they operate. These impacts range from energetic particles in the Van Allen radiation belts disrupting satellite micro-electronics to turbulence in the ionosphere degrading ground-to-space communication links. The space environment is not a static system to be measured once, corrected, and forgotten. Rather, it is a dynamic 'space weather' system driven by unruly radiation and plasma from the solar surface.

Predicting ferocious flares is unreliable at best. To improve the space weather forecast value to operational end-users, scientists with AFRL's Solar Disturbance Prediction Program stationed at the National Solar Observatory's complex at Sacramento Peak, N.M., initiated a project called Solar Fusion. It is a grand "data fusion" effort that aims to bundle state-of-the-art, research-grade solar and space environment data from a large variety of telescopes, satellites, and computer-based models, and make it available to AFWA's Space Weather Operations Center, the DoD's only operational space weather forecast center.

"AFWA relies on real-time solar measurements to allow accurate forecasting of hazardous space weather conditions," said Lt. Col. William Cade, AFWA's Applied Technology Division chief. "AFRL is a perfect partner to support our space weather forecast mission."

"We need to improve the value of space weather forecasting because things like satellite operations and warfighter communication, as well as navigation on the ground are drastically affected by what the sun is doing," said Dr. Nathan Dalrymple, Solar Disturbance Prediction Program manager, AFRL's Space Vehicles Directorate, Kirtland AFB, N.M. "By enabling more accurate forecasts, Solar Fusion allows the Air Force and the DoD to better manage its communication networks and satellite operations."

The first fruits of Solar Fusion were realized in January 2006, when daily solar data began to pass from AFRL to AFWA. The collaboration currently consists of maps of the solar wind speed projected onto the sun and involves a three-step process. First, ground-based facilities including the Mount Wilson Observatory, located above Pasadena, Calif., and the National Solar Observatory, Kitt Peak, Ariz., provide solar magnetic field information to the AFRL facility, situated 15 miles south of Cloudcroft, N.M. Then, program staff generates a source surface map from the

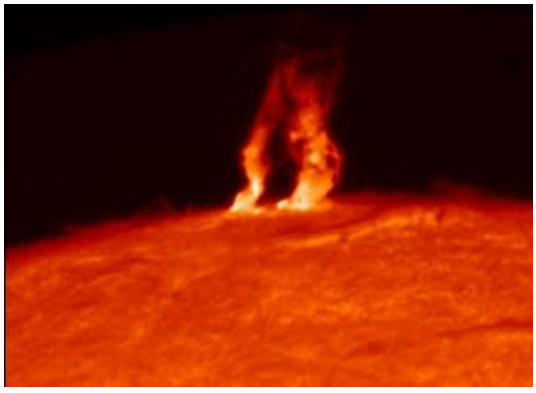
submitted information and send it to AFWA. Finally, AFWA employs the source surface map to initialize the new Hakamada-Akasofu-Fry (HAF) solar wind model, which forecasts when a coronal mass ejection (CME) will strike the Earth. Other ventures between the two agencies have also been planned.

Within the next few months, project personnel will provide solar imagery taken with the Optical Solar Patrol Network (OSPaN) to AFWA, as well as solar magnetic field measurements produced by the Synoptic Optical Long-Term Investigations of the Sun (SOLIS) facility at Kitt Peak, which is comprised of a suite of three instruments with a data handling system offering full-disk solar observations. In addition, program staff will forward to AFWA long-term studies of the sun including climatological research and enhanced solar flare forecasting techniques employing statistical methods.

"We want to be AFWA's research arm and the trusted source of data that they need," said Dr. Richard Radick, Section Chief, Solar Disturbance Prediction Section. "The products of Solar Fusion will allow us (AFRL) to contribute more directly to space weather forecasting and increase our value to the warfighter."

Solar disturbances that hamper military operations include electromagnetic radiation (ultraviolet and visible light, as well as radio frequency emissions), which reaches the Earth within a few minutes; fast particles, traveling at near the speed of light, which impact the globe a few minutes to hours after the flares; and vast clouds of plasma known as CMEs which hit the planet one to three days after erupting from the sun. To detect these space weather storms, AFWA has relied on solar telescopes, satellite measurements, and the intuition of skilled human forecasters. On the other hand, Solar Fusion has already enhanced the current forecasting process by enabling the operation of a state of the art, computer-based CME forecasting tool - the HAF model. When complete, Solar Fusion will provide far-ranging upgrades to our current capabilities, by gathering environmental data from the heavens from a variety of sources including ground-based optical, radio, ionospheric and space-based observatories, as well as empirical/numerical models.

"Basic research, by itself, is not worth much, but when it is transitioned through applied research into operational products it becomes indispensable to the warfighter," said Dr. Dalrymple. "Our relationship with AFWA is a two-way street that we are trying to build and foster and Solar Fusion provides a firm foundation."



Solar flares, like this one photographed on Oct. 31, 2002, disrupt communications, harm satellites, and increase drag on orbiting objects. (Photo courtesy of the U.S. Air Force)

Using the Air Force's Optical Solar Patrol Network telescope and viewed in the hydrogen-alpha spectral line, a sunrise at Sacramento Peak, N.M. is photographed. (Photo courtesy of the U.S. Air Force)